Features

- Supply Voltage: 3V to 36V
- Low Supply Current: 100μA per channel
- Input Common-Mode Voltage Range Includes Ground
- Can Work as Comparator
- Rail to Rail Output
- Bandwidth: 0.9 MHz
- Slew Rate: 0.5V/μs
- Excellent EMI Suppress Performance: 71dB at 1GHz
- Offset Voltage: ±3mV Maximum
- Offset Voltage Temperature Drift: 7 μV/°C
- –40°C to 125°C Operation Temperature Range

Applications

- Power Module
- Sensor Interface
- Motor Control
- Audio

Description

The LM2904A/2902A series amplifiers are newest high supply voltage amplifiers with low offset, low power and stable frequency response. They incorporate 3PEAK's proprietary and patented design techniques to achieve very good AC performance with 0.9MHz bandwidth, 0.5V/μs slew rate and maximum 3mV offset while drawing only 100μA of quiescent current per amplifier. The input common-mode voltage range extends to V–, and the outputs swing rail-to-rail. The LM2904A/2902A family can be used as plug-in replacements for many commercially available op-amps to reduce power and improve input/output range and performance.

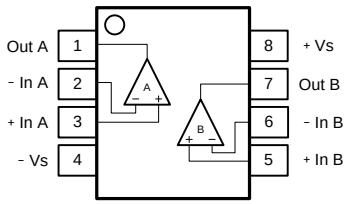
The combination of features makes the LM2904A/2902A ideal choices for power module, industrial control, motor control and audio application.

Pin Configuration

LM2904A

8-Pin SOIC/TSSOP/MSOP

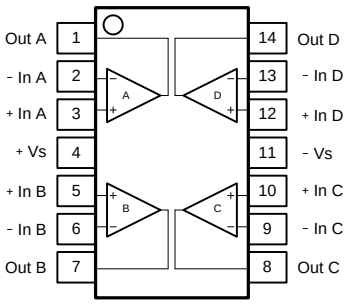
-S, -TS and -V Suffixes



LM2902A

14-Pin SOIC/TSSOP

-S and -T Suffixes



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Revision History

Date	Revision	Notes
2018/3/21	Rev.Pre	Pre-Release Version
2018/10/30	Rev.0	Initial Version
2018/11/11	Rev.0.01	Add LM2902AL1-SR, Correct the condition of VOL,VOH to VS/2, Add mark information.
2019/1/9	Rev.0.02	Update Package Outline Dimension

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
LM2904A-SR	-40 to 125°C	8-Pin SOIC	2904A AAYW Note 1	3	Tape and Reel, 4000
LM2904AL1-SR	-40 to 125°C	8-Pin SOIC	2904A AAYWL Note 1	1	Tape and Reel, 4000
LM2904A-TSR	-40 to 125°C	8-Pin TSSOP	2904A AAYW Note 1	3	Tape and Reel, 3000
LM2904A-VR	-40 to 125°C	8-Pin MSOP	2904A AAYW Note 1	3	Tape and Reel, 3000
LM2902A-SR	-40 to 125°C	14-Pin SOIC	2902A AAYW Note 1	3	Tape and Reel, 2500
LM2902AL1-SR	-40 to 125°C	14-Pin SOIC	2902A AAYWL Note 1	1	Tape and Reel, 2500
LM2902A-TR	-40 to 125°C	14-Pin TSSOP	2902A AAYW Note 1	3	Tape and Reel, 3000

Note 1: “AA” identify the manufacture site. “YW” is the date code means manufacture year and week as following, “L” means MSL1 product.

The calendar year and the workweek coding scheme is as follows:

Year	Code	Year	Code
2010	A	2023	N
2011	B	2024	O
2012	C	2025	P
2013	D	2026	Q
2014	E	2027	R
2015	F	2028	S
2016	G	2029	T
2017	H	2030	U
2018	I	2031	V
2019	J	2032	W
2020	K	2033	X
2021	L	2034	Y
2022	M	2035	Z

Workweek	Code	Workweek	Code	Workweek	Code	Workweek	Code	Workweek	Code
1	1	14	E	27	R	40	e	53	r
2	2	15	F	28	S	41	f		
3	3	16	G	29	T	42	g		
4	4	17	H	30	U	43	h		
5	5	18	I	31	V	44	i		
6	6	19	J	32	W	45	j		
7	7	20	K	33	X	46	k		
8	8	21	L	34	Y	47	l		
9	9	22	M	35	Z	48	m		
10	A	23	N	36	a	49	n		
11	B	24	O	37	b	50	o		
12	C	25	P	38	c	51	p		
13	D	26	Q	39	d	52	q		

Absolute Maximum Ratings Note 1

Parameters	Rating
Supply Voltage, $(+V_S)$– $(-V_S)$	40 V
Input Voltage	$(-V_S)$ – 0.3 to $(+V_S)$ + 0.3
Differential Input Voltage	$(+V_S)$ - $(-V_S)$
Input Current: +IN, –IN Note 2	±10mA
Output Short-Circuit Duration Note 3	Infinite
Maximum Junction Temperature	150°C
Operating Temperature Range	–40 to 125°C
Storage Temperature Range	–65 to 150°C
Lead Temperature (Soldering, 10 sec)	260°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300mV beyond the power supply, the input current should be limited to less than 10mA.

Note 3: A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD Rating

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	3	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	2	kV

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
8-Pin SOIC	158	43	°C/W
8-Pin TSSOP	191	44	°C/W
8-Pin MSOP	210	45	°C/W
14-Pin SOIC	120	36	°C/W
14-Pin TSSOP	180	35	°C/W

Electrical Characteristics

All test condition is V_S = 30V, T_A = 25°C, R_L = 10kΩ, C_L =100pF, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_S	Supply Voltage Range			3		36	V
I_Q	Quiescent Current per Amplifier	V_S = 30V			110	200	μA
			Operating Range			250	μA
		V_S = 5V			100	150	μA
			Operating Range			200	μA
PSRR	Power Supply Rejection Ratio	V_S = 5V to 36V		85	120		dB
			Operating Range	80			dB
Input Characteristics							
V_{OS}	Input Offset Voltage	V_S = 30V, V_{CM} = 0V to 28V		-3	0.1	3	mV
			Operating Range	-7		7	mV
		V_S = 5V, V_{CM} = 0V to 3V		-3	0.1	3	mV
			Operating Range	-7		7	mV
V_{OS} TC	Input Offset Voltage Drift		Operating Range		7		μV/°C
I_B	Input Bias Current				60		pA
			Operating Range		600		pA
I_{OS}	Input Offset Current				60		pA
I_{IN}	Different Input Current	V_S = 36V, V_{ID} = 36V			5		nA
		V_S = 36V, V_{ID} = 36V	Operating Range		20		nA
C_{IN}	Input Capacitance	Differential Mode			5		pF
		Common Mode			5		pF
Av	Open-loop Voltage Gain			95	110		dB
			Operating Range	90			dB
V_{CMR}	Common-mode Input Voltage Range			(V-)		(V+) - 2	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0V to 28V		75	120		dB
			Operating Range	70	90		dB
Output Characteristics							
V_{OH}, V_{OL}	Maximum Output Voltage Swing	R_{LOAD} = 10kΩ to V_S/2			200	300	mV
		R_{LOAD} = 2kΩ to V_S/2			1.1	1.3	V
V_{OL}	Maximum Output Voltage Swing Low	V_S = 5V, R_{LOAD} = 10kΩ to 0V			5	10	mV
I_{SC}	Output Short-Circuit Current				30		mA
AC Specifications							
GBW	Gain-Bandwidth Product				0.9		MHz
SR	Slew Rate	G = 1, 2V step			0.5		V/μs
t_S	Settling Time, 0.1%	G = 1, 2V step			4		μs

	Settling Time, 0.01%				5		μs
PM	Phase Margin	V_S = 30V, R_L=1K, C_L=100pF			60		°
GM	Gain Margin	V_S = 30V, R_L=1K, C_L=100pF			15		dB
	Channel Separation	f = 1 kHz to 20 kHz			120		dB
Noise Performance							
E_N	Input Voltage Noise	f = 0.1Hz to 10Hz			3		μV_{RMS}
e_N	Input Voltage Noise Density	f = 1kHz			70		nV/√Hz
i_N	Input Current Noise	f = 1kHz			3		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1kHz, G =1, R_L = 10kΩ, V_{OUT} = $6V_{RMS}$			0.001		%

Typical Performance Characteristics

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.

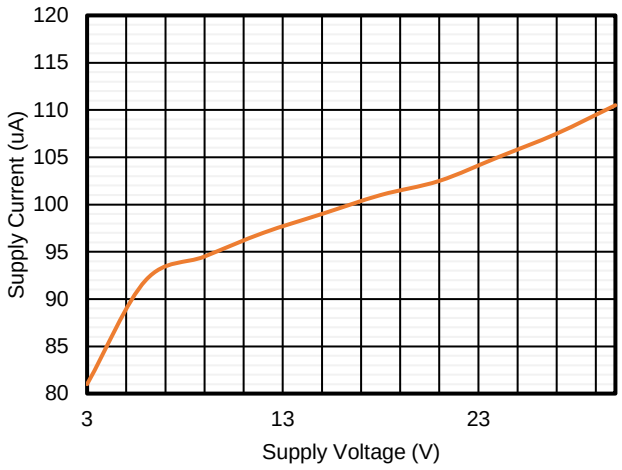


Figure 1. Quiescent Current vs. Supply Voltage

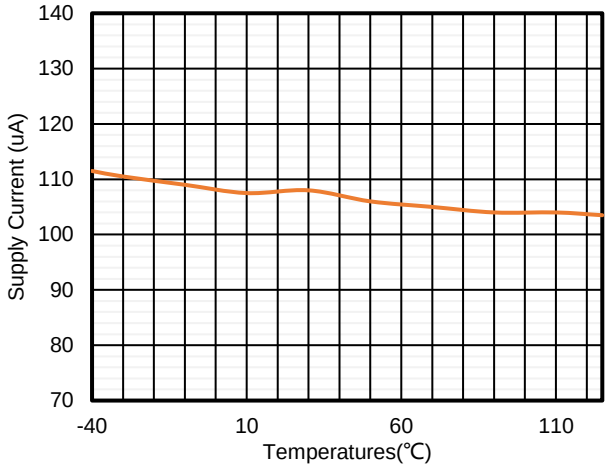


Figure 2. Quiescent Current vs. Temperature

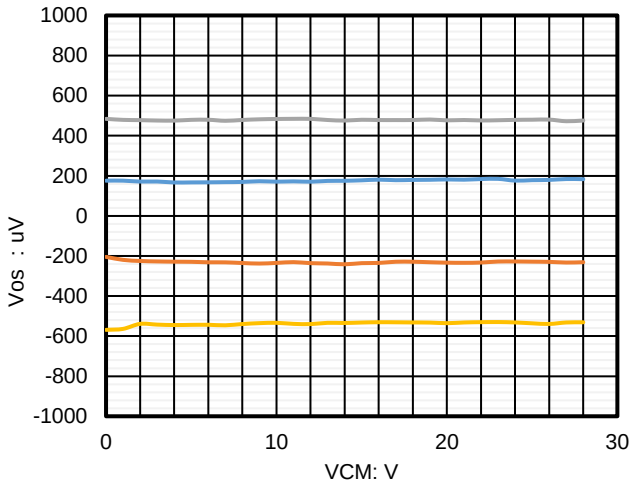


Figure 3. Offset Voltage vs. Common Mode Voltage

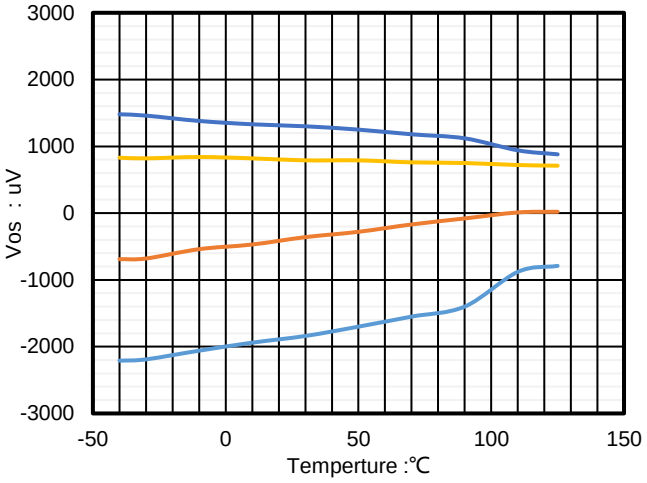


Figure 4. Offset Voltage vs. Temperature

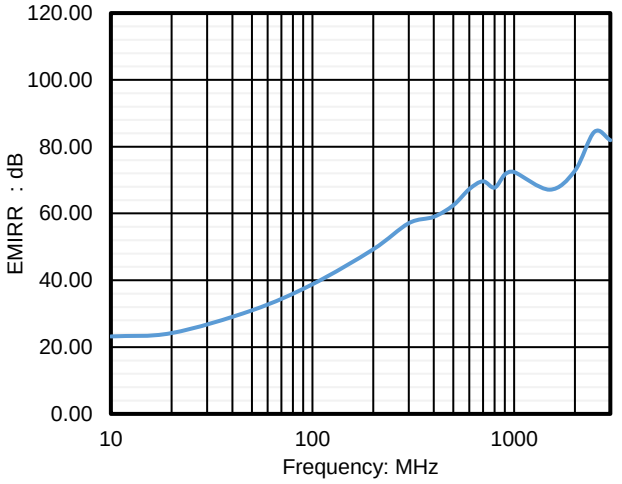


Figure 5. EMIRR+ vs. Frequency

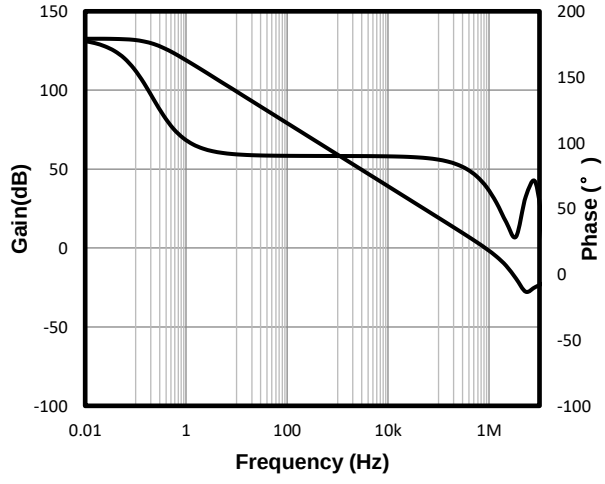


Figure 6. Open Loop Gain and Phase vs. Frequency

V_S = ±15V, V_{CM} = 0V, R_L = 10kΩ, unless otherwise specified.

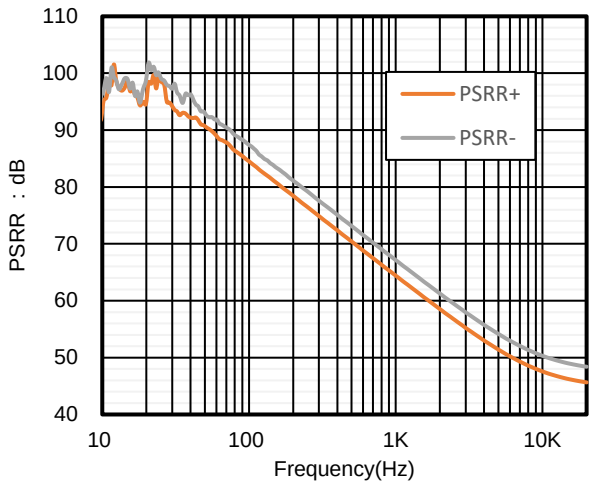


Figure 7. PSRR vs. Frequency

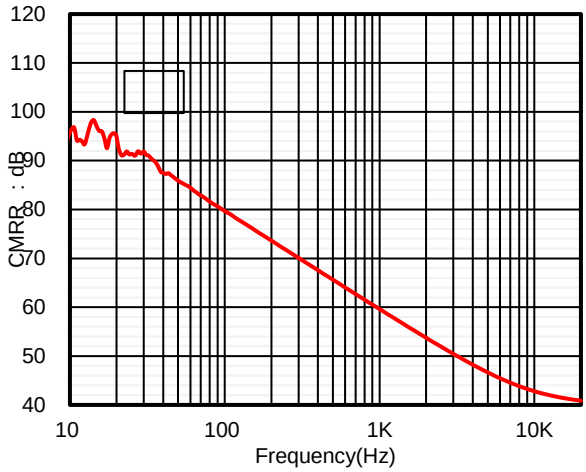


Figure 8. CMRR vs. Frequency

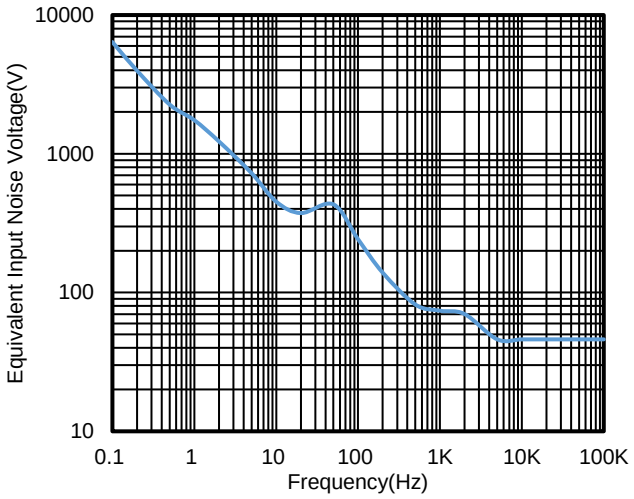


Figure 9. Voltage Noise Spectral Density vs. Frequency

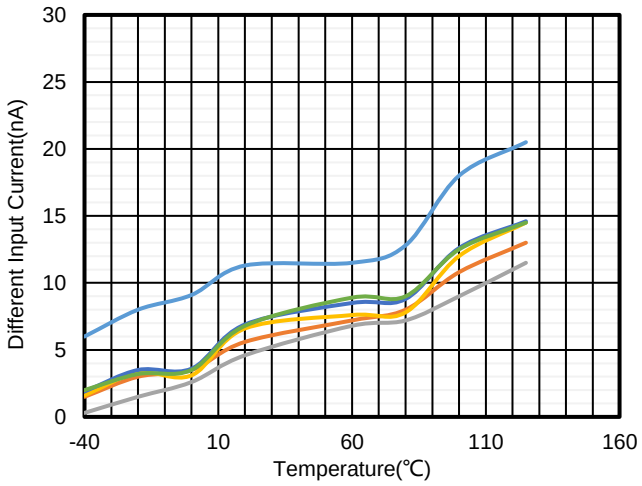
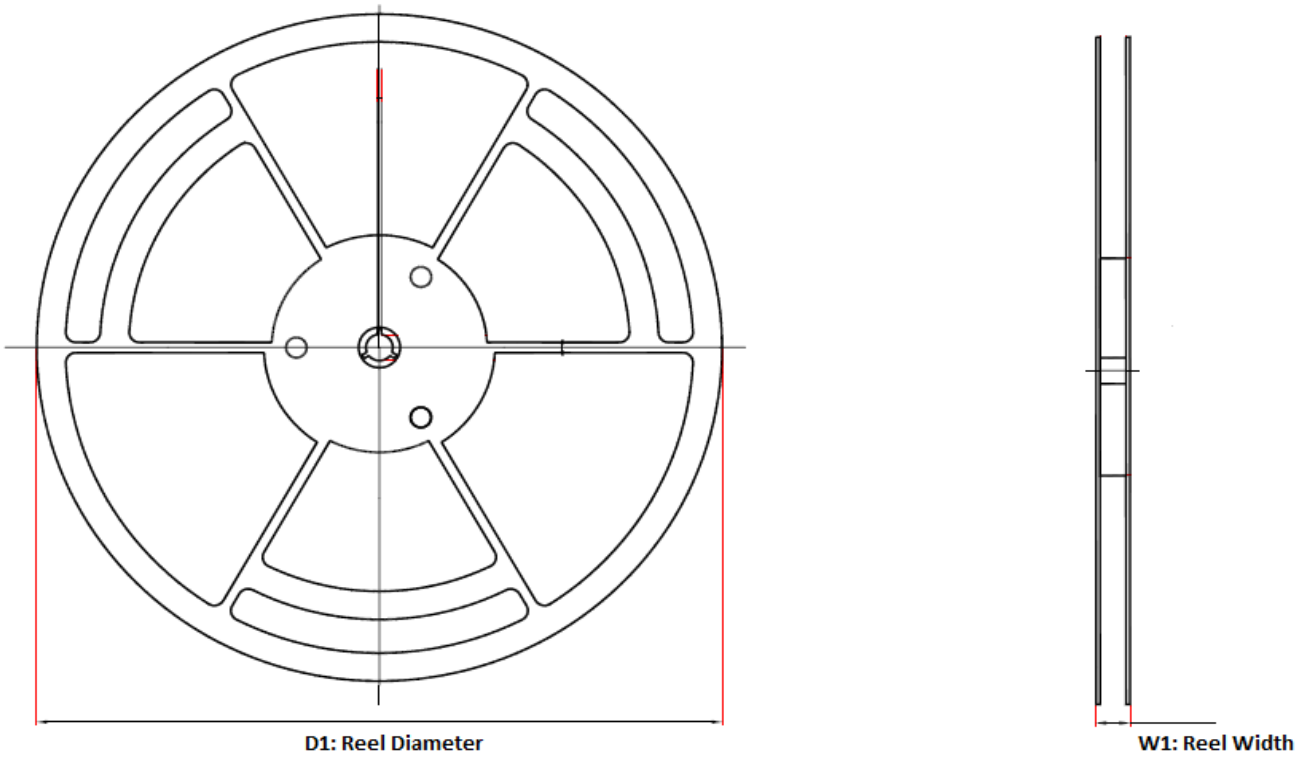


Figure 10. Different Input Current vs. Temperature

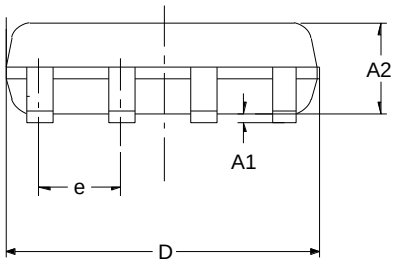
Tape and Reel Information

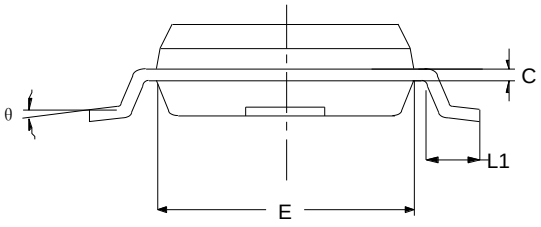


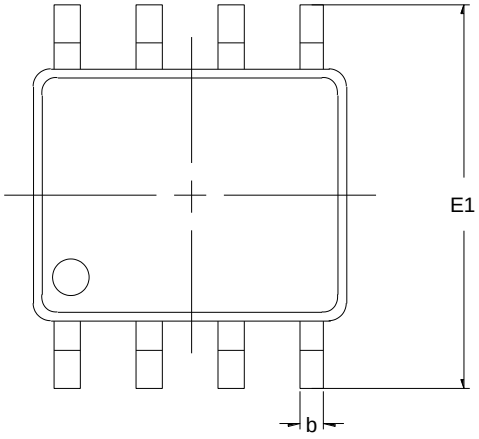
Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
LM2904A-SR	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
LM2904AL1-SR	8-Pin SOIC	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
LM2904A-VR	8-Pin MSOP	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
LM2904A-TSR	8-Pin TSSOP	330.0	17.6	6.8	3.3	1.2	8.0	12.0	Q1
LM2902A-SR	14-Pin SOIC	330.0	21.6	6.5	9.0	2.1	8.0	16.0	Q1
LM2902AL1-SR	14-Pin SOIC	330.0	21.6	6.5	9.0	2.1	8.0	16.0	Q1
LM2902A-TR	14-Pin TSSOP	330.0	17.6	6.8	5.4	1.2	8.0	12.0	Q1

Package Outline Dimensions

SOIC-8

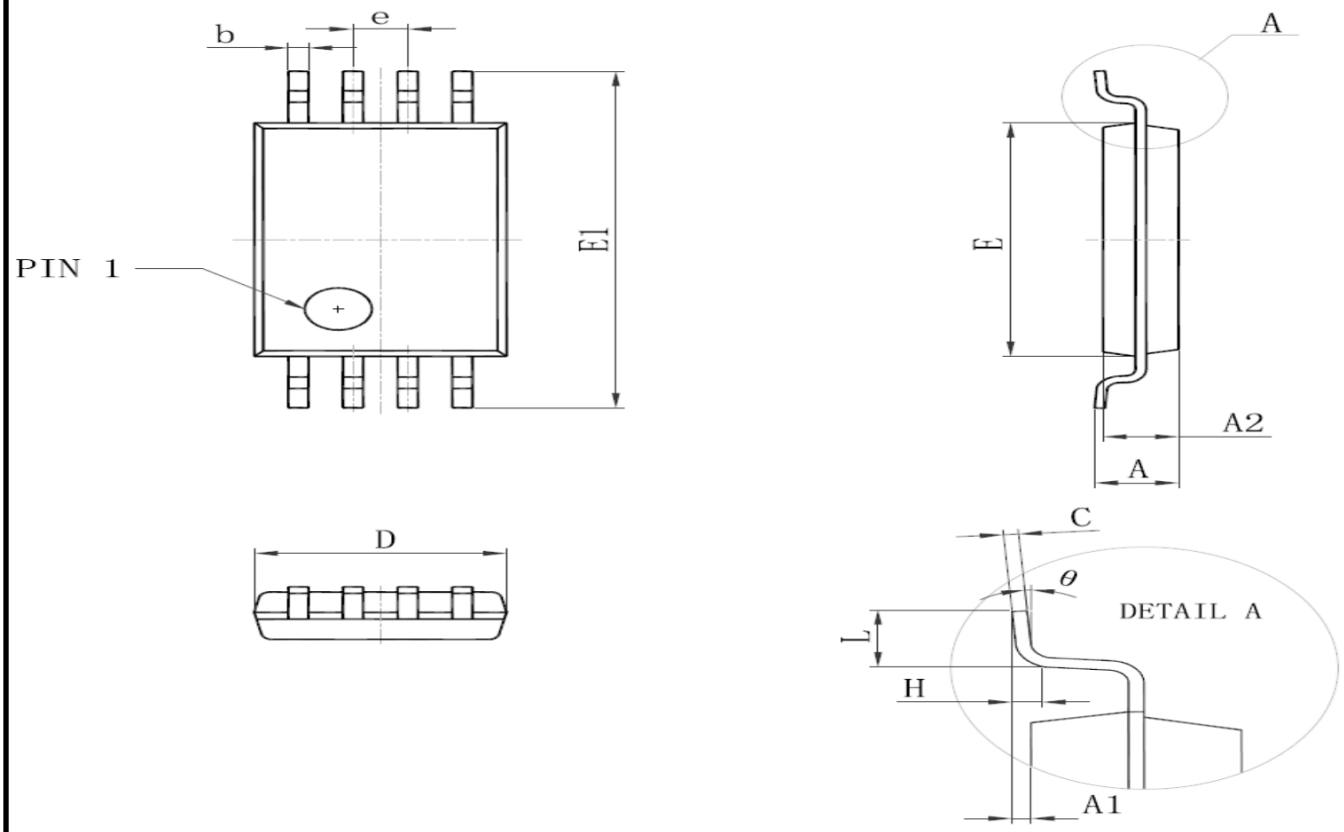






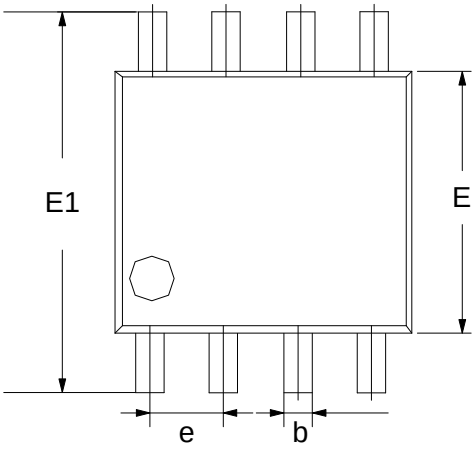
Symbol	Dimensions In Millimeters	
	Min	Max
A1	0.100	0.250
A2	1.300	1.550
b	0.330	0.510
C	0.170	0.250
D	4.700	5.100
E	3.800	4.000
E1	5.800	6.300
e	1.270TYP	
L1	0.400	0.900
θ	0°	8°

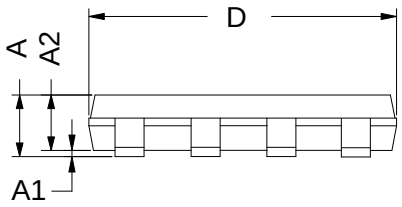
TSSOP-8

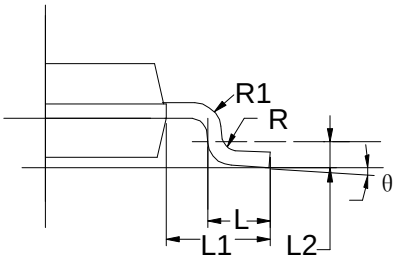


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65(BSC)		0.026（BSC）	
L	0.500	0.700	0.020	0.028
H	0.25(BSC)		0.01（BSC）	
θ	1°	7°	1°	7°

MSOP-8

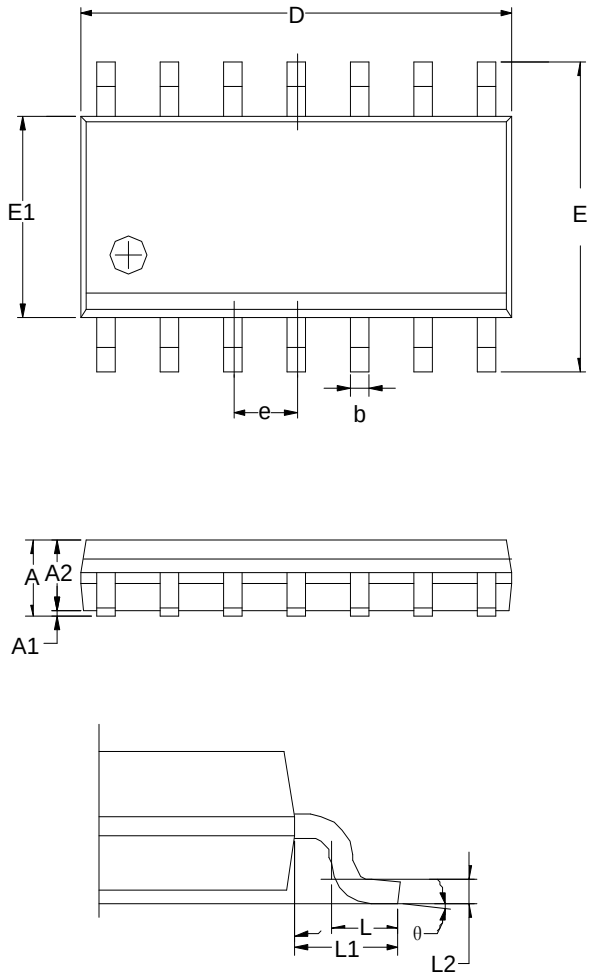






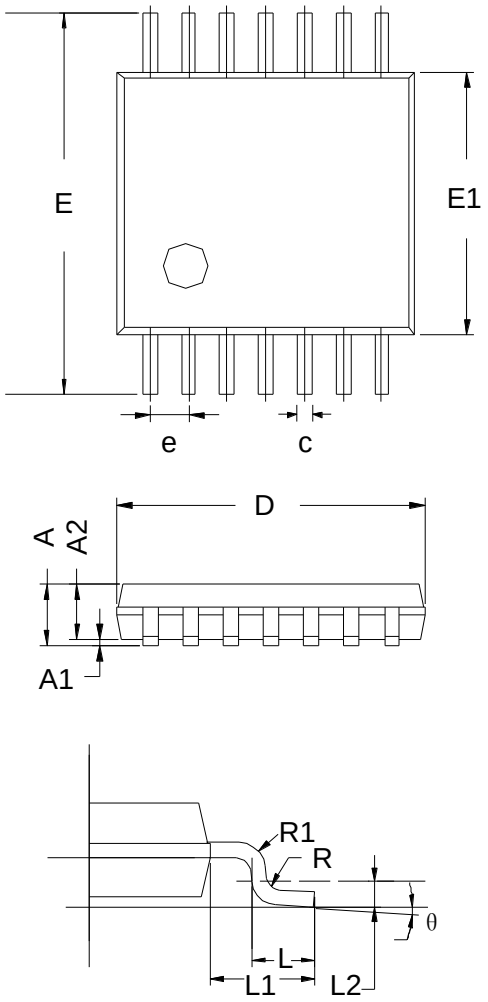
Symbol	Dimensions In Millimeters	
	Min	Max
A	0.800	1.200
A1	0.000	0.200
A2	0.750	0.950
b	0.30 TYP	
C	0.15 TYP	
D	2.900	3.100
e	0.65 TYP	
E	2.900	3.100
E1	4.700	5.100
L	0.400	0.800
L1	0.95 TYP	
L2	0.25 TYP	
θ	0°	6°

SOIC-14



Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
b	0.31		0.51
D	8.45	8.63	8.85
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.40	0.60	0.80
L1	1.05 REF		
L2	0.25 BSC		
θ	0°		8°

TSSOP-14



Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.80	-	1.05
c	0.19	-	0.30
D	4.86	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
θ	0°	-	8°